

03/11/2010

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Application Serial No. .... 10/586,283  
Filing Date ..... November 6, 2006  
Inventor ..... Kassem Ghorayeb  
Group Art Unit..... 2128  
Examiner ..... Saif A. Alhija  
Attorney's Docket No. .... 94.0052; 09469/161002  
Confirmation No. .... 3037  
Title: METHOD AND SYSTEM FOR INTEGRATED RESERVOIR AND  
SURFACE FACILITY NETWORKS SIMULATIONS

**RESPONSE TO OFFICE ACTION OF DECEMBER 15, 2009**

To: Commissioner for Patents  
PO Box 1450  
Alexandria, VA 22313-1450

From: Mark C. Farrell Reg. No. 45,988  
(Tel. 509-290-6316)  
Farrell Patent Law PC  
P.O. Box 142056  
Spokane, WA 99214

## **INTRODUCTORY COMMENTS**

This amendment is in response to the Office Action dated December 15, 2009 with a three month shortened statutory period for reply. Applicant submits that the pending claims are in condition for allowance and respectfully requests issuance of the subject application.

**A Statement of the Substance of an Examiner Interview** begins on page 3 of this Response.

**A Listing of the Claims** begins on page 4 of this Response.

**Remarks** begin on page 8 of this Response.

- Claims 1-4 were previously pending.
- Claims 1-4 are currently amended.
- Claims 6-8 are new.
- Claims 1-4 and 6-8 are currently pending.

## Statement of Substance of Examiner Interview

### Under 37 CFR 1.133

A telephonic Examiner interview between Examiner Saif Alhija and Applicant's counsel, Mark Farrell, was held on February 8, 2010.

Several amendment *concepts* for Claims 1 and 2 were proposed by the Applicant, such as reciting that each simulation task can advance independently to the next synchronization step using different time steps and Newton iterations as each simulation task requires.

The Examiner suggested the possibility of amending to recite that the system or controller couples two *different types* of reservoir simulations, with the two simulations *differentiated* in the claim language. The Applicant also suggested the element of multiple reservoir simulations coupled with Applicant's controller and advancing independently or "asynchronously" through time. The Examiner did not commit to allowability without seeing specific amendments in a Response. Thus, agreement was not reached on any claim at this time.

### **Listing of Claims**

1. (Currently Amended) A method of controlling the coupling of multi-platform reservoir and network simulators comprising:

providing an open message-passing interface capable of communicating with black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks;

initiating a first reservoir simulation for one or more physical parameters of a first reservoir in a first reservoir simulator, the first reservoir simulation using a first fluid model;

initiating a second reservoir simulation for the one or more physical parameters in a second reservoir in a second reservoir simulator, the second reservoir simulation using a second fluid model;

synchronizing applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task;

translating each of a first hydrocarbon fluid stream of the first reservoir simulation and a second hydrocarbon fluid stream of the second reservoir simulation to a common fluid model of a controller by converting pseudo-components of each of the first hydrocarbon fluid stream and the second hydrocarbon fluid stream to a super-set of pseudo-components used in the first reservoir simulator and the second reservoir simulator; and

performing a production operation based on the first reservoir simulation of the first reservoir simulator and the second reservoir simulation of the second reservoir simulator, the first reservoir simulation performed on the first computing device and the second simulation performed on the second computing device using the converted hydrocarbon fluid streams.

2. (Currently Amended) A controller for coupling multi-platform reservoir and network simulators comprising:

means for interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks;

means for initiating a first reservoir simulation for one or more physical parameters of a first reservoir in a first reservoir simulator, the first reservoir simulation using a first fluid model;

means for initiating a second reservoir simulation for the one or more physical parameters in a second reservoir in a second reservoir simulator, the second reservoir simulation using a second fluid model;

means for synchronizing applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task;

means for translating each of a first hydrocarbon fluid stream of the first reservoir simulation and a second hydrocarbon fluid stream of the second reservoir simulation to a common fluid model of the controller by converting pseudo-components of each of the first hydrocarbon fluid stream and the second hydrocarbon fluid stream to a super-set of pseudo-components used in the first reservoir simulator and the second reservoir simulator; and

means for performing a production operation based on the first reservoir simulation of the first reservoir simulator and the second reservoir simulation of the second reservoir simulator, the first reservoir simulation performed on the first computing device and the second simulation performed on the second computing device using the converted hydrocarbon fluid streams.

3. (Currently Amended) The controller of claim 2 additionally comprising means for balancing the coupled multi-platform reservoir simulators, including means for apportioning global production and injection rates constraints between the simulation tasks of the first reservoir simulator and the second reservoir simulator.

4. (Currently Amended) The controller of claim 3 additionally comprising means for balancing the coupled multi-platform reservoir simulators and a surface network[[s]], including balancing the surface network with the global production and injection rates apportioned between the simulation tasks of the first reservoir simulator and the second reservoir simulator.

5. (Canceled)

6. (New) The controller of claim 2, wherein the means for initiating the first reservoir simulation initiates a first reservoir simulation that comprises a black oil model in the first reservoir simulator and the means for initiating the

second reservoir simulation initiates a second reservoir simulation that comprises a compositional model in the second reservoir simulator.

7. (New) The controller of claim 2, further comprising means for coupling additional multi-platform reservoir simulators in addition to the first reservoir simulator and the second reservoir simulator, wherein the additional multi-platform reservoir simulators run a mixture of black oil models with different sets of active phases and compositional models with different sets of pseudo-components.

8. (New) The controller of claim 2, wherein the first reservoir simulator and the second reservoir simulator run on different computer platforms.

## **REMARKS**

- Claims 1-4 were previously pending.
- Claims 1-4 are currently amended.
- Claims 6-8 are new.
- Claims 1-4 and 6-8 are currently pending.

### **Claim Rejections Under 35 USC § 103(a)**

Claims 1-4 were rejected under 35 USC § 103(a) as being unpatentable over **Haugen** et al., “Simulation of Independent Reservoirs Couple by Global Production and Injection Constraints,” in view of **Briens** et al., “Application of Sequential Staging of Tasks to Petroleum Reservoir Modeling,” in view of U.S. Patent No. 6,108,608 to **Watts**, “Method of Estimating Properties of a Multi-Component Fluid Using Pseudocomponents.”

### **Claims 1 and 2**

Claim 1 recites a method of controlling the coupling of multi-platform reservoir and network simulators. Similarly, Claim 2 recites a controller for coupling multi-platform reservoir and network simulators. Similar amendments have been applied to both Claim 1 and Claim 2. No new matter has been added by the amendments, which use language taken from the specification.

Amended Claim 2 defines elements of the controller for coupling multi-platform reservoir and network simulators, including:



- means for interfacing via open message-passing with different types of simulation tasks including black oil model reservoir simulations, compositional model reservoir simulations, and different types of surface networks;
- means for initiating a first reservoir simulation for one or more physical parameters of a first reservoir in a first reservoir simulator, the first reservoir simulation using a first fluid model;
- means for initiating a second reservoir simulation for the one or more physical parameters in a second reservoir in a second reservoir simulator, the second reservoir simulation using a second fluid model;
- means for ~~synchronizing~~ applying synchronization steps to the advancement through time of the first reservoir simulation executing on a first computing device and the second reservoir simulation executing on a second computing device, each synchronization step enabling different simulation tasks to take non-identical time steps, wherein each simulation task of the first reservoir simulation and the second reservoir simulation advances independently to the next synchronization step using corresponding time steps and Newton iterations uniquely suited to the individual simulation task;
- means for translating each of a first hydrocarbon fluid stream of the first reservoir simulation and a second hydrocarbon fluid stream of the second reservoir simulation to a common fluid model of the controller by converting pseudo-components of each of the first

hydrocarbon fluid stream and the second hydrocarbon fluid stream to a super-set of pseudo-components used in the first reservoir simulator and the second reservoir simulator; and

- means for performing a production operation based on the first reservoir simulation of the first reservoir simulator and the second reservoir simulation of the second reservoir simulator, the first reservoir simulation performed on the first computing device and the second simulation performed on the second computing device using the converted hydrocarbon fluid streams.

The cited references, Haugen, Briens, and Watts, alone or in combination, do not appear to teach or suggest an open message-passing interface adapted to couple reservoir simulation tasks being performed under different simulation models (e.g., black oil models and compositional models). These references also do not appear to teach or suggest a loose coupling scheme in which each simulation task advances independently to synchronization waymarks, taking whatever time steps each simulation task requires. Haugen, for instance, appears to describe a tight coupling scheme, in which all the simulation tasks are required to take identical time steps.

The Applicant therefore respectfully requests that the 35 USC § 103(a) rejections of Claim 1 and Claim 2 be removed.

### **Claims 3 and 4**

Claims 3 and 4 have been amended for clarity. No new matter is added by the amendments, which closely follow language in the specification.

Claims 3 and 4 include the all the language and limitations of their base claim, Claim 2. Thus, Applicant suggests that since Claim 2 is allowable, Claims 3 and 4 are allowable in turn.

### **New Claims 6-8**

New Claims 6-8 are added to recite further features of the controller recited in Claim 2. For example, Claim 6 recites the controller coupling a black oil model reservoir simulation with a compositional model reservoir simulation. Claims 7 recites the controller coupling a mixture of black oil models that each have different sets of active phases, and compositional models with different sets of pseudo-components. Claim 8 recites the controller coupling reservoir simulators that are running on different computer platforms.

### **Conclusion**

Applicant submits that the pending Claims 1-4 and 6-8 are in condition for allowance and respectfully requests issuance of the subject application.

Date: March 10, 2010

By:

Respectfully Submitted,  
/Mark Farrell/

Farrell Patent Law PC  
Mark C. Farrell  
Reg. No. 45,988  
(509) 290-6316